

**KEY CHALLENGES AND STRATEGIC OPTIONS
FOR THE
LANDSCAPE DEVELOPMENT INTERVENTIONS PROGRAM
(Part II)**

by Roy Hagen

Eco-Regional Planner

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KEY CHALLENGES AND STRATEGIC OPTIONS FOR LDI

1. Introduction

This document has been prepared as the Landscape Development Program (LDI) is finalizing its choices of the Strategic Intervention Zones (SIZ) in each of its three regions of Fianarantsoa, Moramanga and Mahajanga. LDI will concentrate its agricultural intensification and related natural resources management efforts in these SIZs as well as a good part of its enterprise promotion activities. All of these intervention must be conceived in a strategic fashion to better conserve priority ecosystems in each regions. The next planning phase will involve the development of strategies and plans for each SIZ.

Many of the challenges encountered in the three regions are the same or have many aspects in common. This paper is an attempt to better define some of the principal challenges faced by the LDI regional teams and to propose a range of strategic options for addressing these challenges. These proposals are not intended to be prescriptive. Each regional office has the principal responsibility for developing the strategies and plans that are best suited to the specific situation of their region and of each SIZ. The options presented herein are intended to enrich the understanding of the challenges, the scope of the possibilities for consideration and to facilitate the internal analysis of the advantages and disadvantages of potential strategic options.

2. Land and Resource Tenure Challenges and Strategies

2.1. Land and Resource Tenure Challenges

2.1.1. Essential Conditions for All Resource Management

Well-defined tenure and access rights to land and resources are the most basic condition for natural resource management (NRM). It is not a sufficient condition but it is an absolutely necessary condition, especially under modern day conditions of high population pressures and resource scarcity. Resource managers must be able to control the conditions of access to, and exploitation of, the resources they are to manage. Under conditions of scarcity, sustainable NRM always involves placing limits on the conditions of resource use and exploitation.

Open access precludes all possibility of management. Under conditions of open access to resources, the rational action for the individual is to exploit the resource before someone else does. Investment in resource management, or delaying use today for greater benefits tomorrow is irrational for an individual or for a group if others outside the group have free access to the resource.

2.1.2. Historical Perspective

Prior to the colonial period in Madagascar, as in most countries, most natural resource access, use and management was under local control. Traditional systems typically varied greatly in their equitability and their sustainability. But in general those who depended directly on local resources were those who controlled these resources. The first necessary condition for sound NFM was largely in place.

When Madagascar was colonized, the colonial power put an end to local tenure and control. All land and natural resources came under the control of the colonial administration. Technical services, modeled after those in France, were created within the colonial administration to control the access and use of natural resources. By far the most important is the Waters and Forests Service or *Eaux et Forêts*. Certain non-commercial, local usufruct rights were recognized. Local communities, however, generally had no rights to the commercial use of natural resources. The colonial system is generally recognized as being inequitable in favor of the colonial power.

At the time of independence in 1960, the newly independent government could have completely changed the system of land tenure and resource access rights, but they did not. The newly independent Malagasy government largely adopted the highly centralized system of administration, laws and policies that had been put in place by the colonial power, including those on land tenure and resource access. The newly independent government assumed the same role, in many ways, that the colonial power had played. This has led to the tragic conditions of natural resource use and abuse in Madagascar today.

Although the ability of the government to enforce them has declined dramatically, the formal government legislation and policies on land tenure and resource access have changed little since they were put in place by the former colonial power. Traditional systems exist in parallel and in conflict with the formal legal system.

2.1.3. Present-Day Tenure and Resource Access Rights

Under existing law, renewable natural resources in Madagascar belong to the state. Local communities that depend on forest, wildlife, fisheries, pasture and water resources do not own, and do not have the rights to control, the use of these resources. The legal ownership and control are in the hands of the state, primarily under the control of *Eaux et Forêts*. Even many forms of non-commercial use of resources are subject to the issuance of permits. Commercial forest exploitation requires the delivery of a *permis d'exploitation* by *Eaux et Forêts*.

Although local villagers are not legally excluded from the commercial forest harvest system, the system is organized so that commercial harvest permits are rarely given to

villagers. They almost always go to relatively wealthy businessmen and authorities from the large to small cities. At best, local villagers may be hired as laborers and may receive a share of harvest taxes that are levied. At worst, local communities, who depend on their resources for a wide range of products and environmental services, may be powerless to prevent the exploitation of “their” local resources by outsiders armed with the government issued permits.

The present system remains a highly centralized system that gives very little control or benefit to local communities. The present system is inequitable because it favors urban businessmen over local communities and because control and revenues are concentrated in the hands of central government. The system has the perverse effect of marginalizing the very people with the greatest potential incentive to manage the resources sustainably, i.e., the local communities who depend on these resources for many essential products and services.

What is more, the government services mandated with the oversight of Madagascar’s renewable natural resources totally lack the means and the motivation to manage them. It is not evident that the government has ever managed any of the biological resources (forest, wildlife, fisheries, and range) in the modern sense of resource management. Resource management calls for basic elements such as:

- definition of management objectives;
- the development of strategies for assuring that the resource is renewed or regenerated;
- some type of monitoring system to insure the productivity of the resource is maintained and that harvest does not exceed yield, growth or regeneration of the resource over time;
- A system for reinvesting a portion of the benefits from resource use back into regeneration/management of the resource.

A new law was passed in September 1996 that would make it possible for the State to transfer the rights to the control, management and harvest of renewable natural resources to local communities. It is called *Loi sur la Gestion Communautaire Locale des Ressources Renouvelables – Loi No. 96-025*. As of mid-December 1998, the enabling legislation or *textes d’application* had not yet been approved, so the law is only being applied on a test basis to date. The law is commonly referred to as GELOSE or *la Gestion Locale Sécurisée des Ressources Renouvelables et du Foncier*. A closely equivalent expression in English is community-based natural resource management or CBNRM. This potential application of this law for addressing tenure and resource access policy constraints is discussed in Section 2.2.

2.2. Land and Resource Tenure Strategies

2.2.1. General Perspective on CBNRM/GELOSE

In the present context, it is virtually inconceivable that the state will develop the motivation and the means to manage any more than an insignificant fraction of Madagascar's forest, range, wildlife and fisheries resources in the foreseeable future. One of the only promising strategies for sustainable NRM, and with it, for conserving much of Madagascar's biodiversity outside of its protected areas, is in community-based control and management of renewable natural resources. Under the lack of presence of agents of the state and the lack of empowerment of local communities, natural resources are increasingly used and abused as open access resources, exploited by all and cared for and managed by no one. Agricultural land and renewable natural resources are the base of rural economies in Madagascar. These resources have value. Open access allows them to be exploited as though they have no value.

Local communities have the local presence at the level of the natural resources that *Eaux et Forêts* lacks. Local populations usually know in great detail who is using which resources and how. Local communities frequently already have a degree of motivation to conserve these resources, although the strength of this motivation is very difficult to quantify. They presently lack the empowerment to control their resources. Human nature being what it is, their disempowerment sometimes leads to apparently irrational acts such as the intentional setting of forest and range fires to manifest their political discontent. Local communities invariably have a high degree of local technical knowledge of their resources. Local knowledge is a critical, largely untapped, resource needed in the development of resource management systems.

GELOSE provides a basis for rural communities to organize themselves into legally constituted bodies to which the state may transfer management rights over some or all of the renewable natural resources on all or part of the communities' traditional lands or *terroir*. GELOSE provides the clearest, but not the only, mechanism, that LDI may make use of in its three regions for addressing tenure and resource access constraints outlined above.

A five-page review of the strengths and weaknesses of this law was drafted by the author in French in December 1998. It is called *Analyse des Points Forts et des Points Faibles de l'Approche GELOSE*. It is available through the LDI office. The reader is encouraged to read this document for a better understanding of strategy recommendations concerning GELOSE.

GELOSE is based on a good idea but it is a very imperfect law. It is heavily focused on process and administrative procedures and less focused on content and results. It includes some very questionable requirement such as the obligation of engaging an environmental mediator and, more importantly, the obligation to undertake a *sécurisation foncière relative* or informal registration of all agricultural lands of the communities

concerned. All that said, it does provide a basis for transferring exclusive rights to communities over renewable natural resources. As argued in 2.1.1., this is an absolutely essential condition sound NRM, and this is the greatest potential strength of GELOSE.

Although the GELOSE law itself seems very cumbersome, the team of specialists within ONE who are charged with developing the approach seem to be very flexible and open to suggestion for making GELOSE workable. Although the law will definitely lead to frustrations, resource tenure is so critical that LDI should work closely with this group to test and improve on the GELOSE approach for CBNRM.

2.2.2. Conditions under Which GELOSE May Play a Strategic Role for LDI

2.2.2.1. Communities Wishing to Put and End to Open Access of Their Terroir

Communities under pressure from outsiders. Open access is the probably the greatest threat to sustainable resource use. Perhaps the greatest opportunity for using GELOSE/CBNRM is under situations where two conditions exist:

- renewable natural resources within a community's *terroir* are being exploited by people or organizations from outside the community, **and**;
- the community is already motivated to prevent this or to control the conditions of access to resources within their *terroir*.

The outsiders could be migrants wishing to clear forestland for *tavy* agriculture or they could be *exploitants forestiers* armed with *permis d'exploitation* by the government or other groups.

Using GELOSE or another mechanism to establish community rights over their resources could have the major benefit of putting an end to open access resource exploitation and the loss of natural area even though there is no other improvement in the management of the resource by the community. Transfer of rights to communities over their *terroirs* and their resources could have two positive impacts:

- It formalizes the limits to their land and their resources in the mind of the community members. This should reinforce the idea in their mind that “these are our resources and we must learn to live within the constraints of our resource base”;
- As the transfer of rights gains momentum, it should create a growing perception within the regions and then the nation that the epoch of open access resources is coming to an end.

Andringitra/Ranomafana potential. H Schar, formerly regional director of the CAP Project, believes that one of the causes of accelerated clearing for tavy on the east side of the Andringitra to Ranomafana Corridor is due to immigration by tavy farmers coming from the Manakara region. Under traditional tenure rules, land belongs to the first family to clear the forest and to farm it. If local people are unable to control forest clearing for agriculture within their *terroir*, they may very well accelerate their own clearing of the forest in order to secure traditional tenure.

Such a land rush mentality may easily accelerate in the future as growing, impoverished populations become increasingly desperate and increasingly mobile. The “Go West, young man” mentality of unlimited resources and the perception that one can always move on and clear more forest elsewhere if local resources and soils are depleted, is one of the fundamental causes underlying much of the loss of forests and natural areas in Madagascar.

One potential approach for consideration in the Andringitra to Ranomafana Corridor would be to divide part or all of the forested corridor amongst the contiguous villages under GELOSE contracts. Communities around forests, even around *forêts clasées* and protected areas, frequently have already divided these forests up amongst themselves. The contracts could stipulate the portions of forest that will not be cleared or converted to agriculture. We don’t know what restrictions on future conversion to tavy fields communities would agree to, but the option would be worth investigating.

Lac Aloatra marshlands Communities adjacent to the marshlands around Lac Aloatra are, according to Jersey Wildlife, very motivated to protect their marshlands. If this is true, then GELOSE could be an effective strategy for conserving these marshlands. It is certainly an alternative to creating a protected area. At Lac Aloatra, community rights over marshlands could be further extended to community rights over the fisheries resource in the lake.

Rights to the full *terroir* or some portion thereof? The GELOSE law leaves it open to the community and the parties concerned as to whether the transfer of management rights will cover a community’s full *terroir* or some portion thereof. The law makes provision for transfer of rights over forests, pasture, watersheds and water and also makes provision for “relative tenure security” over agricultural lands. These should make it possible for any community to request the transfer of management rights over all of the resources in their *terroir*. (Virtually all land and water bodies are part of a watershed and virtually all *tanety* grasslands in the western ¾ of the island are used as pasture.)

LDI should encourage communities to request rights over their full *terroir* to reinforce their sense of ownership and to end open access to resources.

2.2.2.2. The Strategic Role of SFR

One of the draft pieces of enabling legislation would require that *sécurisation foncière relative* (SFR) be applied to all cases of transfer under GELOSE. SFR translates approximately as relative tenure security. It involves the preparation of large scale map (at least a sketch map) and the informal registration of the “owner” of each field (and fallow?). It does not include the awarding of land titles to field owners. It will probably prove to be the most time consuming and expensive component of the GELOSE process.

It may prove to be a worthwhile approach where conflicts over tenure of agricultural land are a constraint to agricultural intensification.

However, SFR appears to be largely superfluous to the community-based management of non-agricultural forests, marshes, fisheries/water bodies and rangelands. In situations where tenure of agricultural lands is not a significant constraint and where the focus is on the management of non-agricultural lands, LDI should seek to modify the GELOSE process to bypass or minimize the need for SFR on agricultural lands. The essential requirement for CBNRM is that the limits of each community's *terroir* be legalized with well-defined boundaries recognized by neighboring communities and the state.

Surveys of agricultural lands and registration, even informal, of fields and fallow are typically a very time consuming process. Requiring SFR in all cases of GELOSE may severely limit the number of communities and amount of area to which this approach may be applied within LDI's SIZ's. Simply registering the limits of a community's *terroir* could go much more quickly.

2.2.2.3. GELOSE as Incentive for the Structuring of Rural Communities

Many or most rural communities with whom LDI will work are unstructured or very poorly organized. Working with unstructured communities can be very inefficient. Promotion of agricultural intensification and NRM in unstructured communities may have little impact. However, simply requiring that a community structure itself in order to receive project assistance is a rather artificial approach that may not lead to a strong, viable community structure. CBNRM, by its very nature, necessitates the development of strong community structures. The GELOSE law requires that communities organize themselves into legally constituted bodies to which the State transfers management rights. The same community structure put in place for GELOSE can serve multiple functions, including facilitating LDI's support for agricultural intensification.

3. Challenges Related to Wildfire

3.2. Ecological Importance of Fire for Biodiversity Conservation

It would be easy to argue that fire is the single most important ecological factor that has determined the present day vegetative cover of Madagascar. Although natural lightning caused fires do occur in Madagascar (Drs. Ron Nussbaum and Martin Nicoll have both witnessed lightning-caused fires in SW Madagascar), the natural fire regime that existed prior to the arrival of man must have been very, very different from the man-dominated fire regime that exists today. PACT's fire monitoring system shows that a very large part of Madagascar's *tanety* grasslands burn every year. It also shows that fires are very common within the remaining blocks of western Dry Forest. Nearly all Malagasy forest species are incapable of regenerating under the existing fire regime or of recolonizing areas that were previous forested.

Even more seriously, fire is degrading and destroying forest lands and converting them to infertile, unproductive *tanety* grasslands. It is especially serious in the remaining areas of Dry Forest. In LDI's Mahajanga Region, fire is clearly the major threat to the Dry Forest. Fire also encroaches continually into the eastern rainforest. Tavy is not generally a major problem on the west side of the eastern escarpment rainforests, but wherever rainforest is bordered by grasslands, the nearly annual fires burning up the steep grass slopes destroy a few more meters of rainforest with each passage.

As is typical for tropical forests, most nutrients essential for plant growth are bound up in the biomass of the forest, both the living trees herbaceous plants and the duff and soil organic matter. Fire mineralizes the nutrients and most are lost from the ecosystem. Most Malagasy soils are so old and so highly weathered, that, with the loss of most of their organic matter, they become some of the poorest soils in the world. The soils are so poor, that the typical *tanety* grassland has a plant species diversity of one or two or three species of pan-tropical perennial grasses (Martin Nicoll, personal communication) and a biomass that only partially covers the soil's surface at the end of the rainy season. The *tanety* grasses are those that are adapted to survive on these exceptionally infertile soils. As of 1989, none of the dozens of improved pasture/range grasses that had been introduced/tested over several decades would survive more than a few years on the typical *tanety* soil unless amendments were first added to improve the soil fertility (Personal comm., FOFIFA director of livestock and pasture/range research).

3.2. Reasons for Burning

3.2.1. Technical reasons

Range fires. There are several technically-based reasons for burning. The most widespread is the burning of grasslands to improve their use as rangelands for cattle. The FOFIFA director cited above told the author in 1989 that the grasses of the typical *tanety* become unusable for cattle if they are not burned every two or three years. They become so lignified and low in nutritional value that they lose most food value for cattle. *Tanety* are typically burned at the end of the dry season. The meager regrowth from the perennial root system is much more palatable to livestock. Of course the repeated burning almost certainly leads to further decreases in soil fertility over time.

Fire for improved fertility of rice paddies Another reason for burning occurs in situations where rice paddies are found downslope from *tanety* grasslands. Some of the nutrients in the mineralized ash will be washed down into the rice paddies with the first rains. Some workers on agroforestry/agricultural development projects report that farmers have told them that this is a reason for burning.

Fire to increase runoff FOFIFA has a research site north of Ankazobe just off of the Antananarivo to Mahajanga road where 15 years continuous data on runoff and soil loss was recorded on four experimental watersheds. Two of the watersheds were typical High Plateau *tanety* grasslands. One was completely protected over the 15 yr. period; the

second was burned every second year to imitate prevailing conditions of the High Plateau. The *tanety* watershed burned every other year had twice as much average runoff per ha. as the unburned watershed. The other two watersheds were covered by a pine plantation and rainfed agriculture with contour bands of perennial grasses to control erosion, respectively. The runoff from these two land uses were less than 1/6 of that of the *tanety* burned every two years.

The High Plateau has a marginal climate for rice production because the climate is too cold towards the end of the growing season. If rice is not transplanted early enough, the cold temperatures toward the end of the growing season significantly reduce yields. Yields tend to be a direct function of how early one can transplant their rice seedlings out into their rice paddies. Transplanting cannot take place until rice paddies are flooded. The majority of rice paddies on the High Plateau are dependent on runoff as the source of water. Burning the *tanety* increases runoff and makes it possible to flood more of the paddies at an earlier date. Many or most farmers have made this correlation.

General perspective on technical reasons for burning. The reasons cited above are real. Their relative importance is largely unquantified; they need further study – especially to understand their local importance in the specific zones where LDI will work. In developing strategies for fire management, they should not be ignored.

3.2.2. Cultural Reasons for Burning

For technical reasons for burning, one can hope to find a technical solution. Cultural reasons are tied up with beliefs, traditions and cultural values. They require a very different set of strategies. A few of the cultural reasons follow:

Belief that burning will bring the rain. There is a strong belief in at least some parts of Madagascar that fire, or perhaps the smoke from fires, will trigger the onset of the rainy season. This type of burning is practiced primarily when the beginning of the rainy season is delayed. Of course, this corresponds to drought conditions when forest and fallow vegetation is the most susceptible to damage by fire. This belief has been encountered in the Ranomafana and the Mahajanga areas. It was a major problem when the rains came late in 1996.

It has been suggested that there may be some technical basis for this belief – that smoke particles could provide the nuclei onto which water vapor may condense in a way similar to a cloud seeding operation. The author has never heard of any scientific evidence that would support this theory. In any case, modern cloud seeding is only done when atmospheric conditions are known to be favorable for rain to develop with a little assistance.

Fire as a medium for manifesting political discontent. The Malagasy have a well-developed tradition of using *tanety* and forest fires to manifest political discontent. This phenomenon exists also in other countries, but it seems to be developed to an exceptional

degree in Madagascar. If someone wants to light a fire without being caught, it is almost impossible to prevent this. Wildfires provide a highly visible, dramatic way of making a statement against unpopular government policies or authorities.

One of the key government policies against which people protest by lighting fires was the policy decision taken about 1976 to ban all fires. Elyette Rasendratirofo reports that a recent MEF workshop revealed that prior to 1976, it was relatively easy to get permits to burn provided that certain precautions were taken. In 1976, the government reportedly decided to ban all fires. At the same time, the enforcement of natural resource laws was sharply curtailed. The use of fire has become widespread and uncontrolled since that time.

The way of the ancestors. Malagasy respect for the traditions of their ancestors is exceptionally strong. Burning practices that correspond to traditional burning practices are reinforced by this belief.

3.2.3. The Depth of Our Lack of Understanding

Early versus late-dry season fires. The depth of our lack of understanding of burning practices in Madagascar is easy to illustrate. Western Madagascar has a climate that is similar in many ways to that of the tall grass savanna zone (Sudanian and Sudano-Guinean zones) of West Africa. Both have a very hot climate with an extended dry season up to eight months in length. The author studied fire regimes in West Africa while at the Regional Remote Sensing Center of Ouagadougou in the early 80's. The frequency of fires in the tall grass savanna zone of Burkina Faso was at least as high as that in Western Madagascar. Over 97% of savanna forests burned every year. Fires are set by rural populations. As in Madagascar, the main reason for burning is to get the succulent "green bite" for livestock.

However, in West Africa nearly all early dry season fires are set during the first month and a half of the dry season when grasses are still partially green, trees and shrubs are still in leaf and soil moisture is high. Fires do not burn very hot and the savanna trees and shrubs are well adapted to thrive and reproduce under these conditions. Mid to late dry season fires in the same zone are highly destructive to the woody vegetation.

In Madagascar, most fires are set at the end of the dry season. The author asked many people at many levels why this should be. Why are nearly all fires in Madagascar set at the end of the dry season? Most people don't even have a hypothesis to advance. Is the reason technical or cultural or some combination of both? We simply do not know.

Lack of expertise on fire ecology and management

Given the key ecological, economic, social and political roles of fire in Madagascar, the lack of expertise on fire ecology and management is quite astonishing. There has been little research done on either traditional fire management or on the present causes,

impacts and systems of fire use. The general mentality is that fire is bad, that it is something to fight against (*la lutte contre les feux de brousse*). Little effort has been made to understand and to manage fire. The author knows of no Malagasy with higher degrees in fire ecology or management.

3.2.4. Historical Perspective

Traditions Little is known about pre-colonial fire management systems. One would assume that local fire management systems and techniques would have been highly developed, that the effects of fire frequency, timing and intensity on range, forest and other vegetation types would be well understood and would have been used to achieve specific objectives. Use of fire may have been ritualized and subject to strong cultural norms. How much of the indigenous technical knowledge on the use and impacts of fire still exists is an open question.

For example, charcoal makers in the Amboromaika Forest (where the CAP Project is working on CBNRM) told us that it was traditionally *fady* (taboo) to set fires in the forest. The same type of *fady* existed in the Bora protected area east of Antsohihy. These taboos at both sites have broken down in the last two or three decades. Jersey Wildlife reports that people in the Soalala WSW of Mahajanga had well developed range management systems involving differences in timing and frequency of fires to favor specific range grasses. Their traditional fire management included the use of early dry season burning.

Colonial period through the mid-70's. During the colonial period, strong restrictions were placed on the use of fire and fines were levied for infractions. These policies were continued and largely enforced until about 1975. When asked how cattle were able to use the *tanety* grasses without frequent burning during this time, villagers in the Bealanana *cuvette* replied that they didn't need to. There was plenty of forage throughout the year on the much more fertile plains.

Mid-70's to the present. Enforcement of natural resources laws declined sharply from 1975 onwards. Although fires were banned outright about 1976, the ban had the opposite effect. The use of fire has become so widespread and uncontrolled that most grasslands burn annually, Dry Forests are being rapidly degraded and destroyed. Traditional fire management systems have largely disappeared. The state has lost nearly all control over the use of fire and local communities have not been empowered to manage their use of fires. Although it is difficult to envisage natural resource management without including fire management, the GELOSE legislation makes no mention of community control and management of fire.

3.2.5. Strategies for Fire Management

General Principles. The following principles are proposed as a basis for developing fire management strategies that can aid in conserving priority ecosystems and in developing

sound natural resources management:

- Local communities and their members are in the best position to control and manage the use of fire within their *terroirs*. Fires are set by local people;
- To the extent that local communities and/or their members own or control the management of natural resources, and to the extent that they derive benefits from this control and management, then they will have economic incentives for using fire management or fire prevention as a management tool for the sustainable management of their resources;
- To the extent that they still exist, local technical knowledge and traditional fire management systems should provide the best base on which to build new fire management systems;
- LDI should never take the position that all fire is bad. One should think in terms of fire management, not in militaristic terms of “*lutte contre le feu*”. Fire should be thought of as a legitimate management tool whose proper role remains yet to be defined.

GELOSE/CBNRM Wherever communities derive benefits from natural areas that are threatened by fire, or wherever communities are motivated to conserve such areas, for whatever reason, GELOSE/CBNRM should be considered as a strategy option. As an example, the Amboromaika Forest previously cited, is to be managed by the community of Marofiatsaka. The forest is used by cattle owners for dry season pasture. The cattle owners come from some distance away with their cattle and they leave their cattle “run wild” in the forest unattended during the dry season. The forest is exploited as an open access resource.

At the end of the dry season the cattle are semi-wild and difficult to capture. To make capture easier, the cattle owners simply set fire to the forest to chase the cattle out into the *tanety* where they can be easily captured (This is one of the forests where it used to be taboo to set fire in the forest). If the local community of Marofiatsaka is given management rights to the forest, they should then be able to control the conditions of use of the forest as pasture and to deny access to any groups using fire as a labor saving device for rounding up cattle. Without such control, repeated fires will almost lead to the destruction and disappearance of this forest.

Community-based management may be one of the only viable options for saving the Dry Forest from destruction by fire. Ironically, it is a strategy that would appear to have the highest potential for use on the *forêts domainiales* and the *forêts clasées* as opposed to protected areas like Ankarafantsika. Protected areas do not allow for extractive use or for community management.

Need for community structure and cohesion A strong, cohesive community structure is needed if a community is to control and manage the use of fire within its *terroir*. GELOSE requires that communities structure themselves before management rights can be transferred. Whether or not the GELOSE approach is used, a strong community

structure is essential. Such a structure should be representative and should have the means to sanction community members who do not adhere to the decisions of the group regarding the use of fire.

Need for understanding of traditional and current fire management/use systems. A much better understanding of the traditional and current ways of using fire and reasons for burning is needed in LDI's SIZ's. Obtaining good information on current use of fire is a very sensitive subject. Each LDI regional team will need to judge how best broach this subject. Good information on such a subject can only be obtained if and when mutual trust is established between project staff and communities in the SIZs. Options include direct dialogue by LDI staff, PRA team, *expert junior* or university student working on a thesis or special project.

Early dry-season controlled burns. The most effective and cost efficient way of protecting many natural forests and man-made forest plantations from destructive late dry season wildfires is through the use of early dry season controlled burns. Early burns can usually be done relatively "safely" when grasses are still partially green, when fires are much easier to control and when the fires do not burn hot enough to cause much damage to woody vegetation. Early burns can be used to create firebreaks around natural forests that a community or others wish to protect. Early light burns can often be done inside an older tree plantation itself with little damage for the purpose of eliminating the possibility of destructive, late dry-season fires.

Most *tanety* burn each year. Where such grasslands border forests or plantations, the late dry season *tanety* fires encroach and degrade/destroy the margins of the forest. In the Dry Forest, *tanety* fires many enter and continue spreading into the forest itself when conditions are suitable. By burning of strips of grassland around such forests and plantations early in the dry season and thereby creating a firebreak, the late dry season burns can be prevented from doing damage to the forest or plantation. This has been done operationally by two villages near Soalala WSW of Mahajanga for the last three or four years. It is being done with the permission and the encouragement of *Eaux et Forêts*. The Regional Forestry Director in Mahajanga is reportedly very supportive of this initiative.

Jersey Wildlife has served as a facilitator for this early burning program. Such an initiative is very exceptional in Madagascar. ANGAP intends to begin a similar experimental program at Isalo National Park this year. The Andohahela staff are thinking along similar lines. A key constraint to such programs is the lack of tested and proven techniques and the lack of trained technicians in the area of fire management. This is a problem for LDI, because LDI is not intended to be a research program. However, the fire problem is so fundamental and so widespread, that LDI will need to deal with it and to develop a level of capacity in this area.

4. Tavy Slash-and-Burn Agriculture

4.1. Sustainability of Tavy

The basic problem with *tavy* slash-and-burn agriculture in Madagascar is that it is an agricultural system that is unsustainable as practiced today with short fallows of only a few years. *Tavy* agriculture as practiced today, cannot sustain soil fertility. With each *tavy* cycle, soil fertility decreases and yields decrease. *Tavy* rice and cassava is alternated with *savoka* wooded fallow. With each successive cycle of *tavy/savoka*, the amount of grass in the *savoka* increases until the *savoka* can carry a fire in the dry season. Once the *savoka* burns, the fire greatly favors the growth of grasses over woody fallow vegetation. Under the prevailing burning practices, the former *savoka* becomes permanent *tanety* grasslands (except where colonized by fire-adapted invasive woody exotics). The grasses are not nearly as effective in restoring soil fertility as deep-rooted woody vegetation. Once grasses take over, the land is usually (with exceptions) no longer usable for agriculture because of inadequate soil fertility and because of competition between grasses and *tavy* crops.

Most Malagasy soils are so old and so highly weathered that the mineral content of the soil has very low capacity to retain essential nutrients. In natural forest ecosystems, nearly all nutrients are held and recycled within the above and below-ground biomass. Soil fertility, soil structure and soil moisture holding capacity are all highly dependent on soil organic matter. With each cycle of *tavy*, more soil organic matter is mineralized. Minerals are leached or washed away in the ash, the soil becomes very acid, phosphate is bound up in forms unavailable for crops and the overall fertility and productivity of the soil is severely reduced.

Although all *tavy* is believed to result in continuing declines in soil fertility to the point of abandonment, the rate at which this occurs varies greatly. Some *tavy* is more sustainable than other *tavy*. *Tavy* has been practiced at Beforona for half a dozen cycles since the “primary” forest was cleared about 1975. Although yields are continuing to decline, most of this area is still under *tavy* cultivation after about 24 years. In some areas of eastern Madagascar, rainforest can be converted to *tanety* by a single cycle of *tavy*. When interviewing *tavy* farmers in a village 35 km NNE of Tolanaro in 1991 on the east side of Tsitongambarika Forest, the author learned that droughty, sunlit, north-facing slopes were often converted from Low Altitude Rainforest to *tanety* by just one or two cycles of *tavy*. On the opposite, south-facing side of the same valley, *tavy* had been practiced for 21 years.

Such differences in relative sustainability have huge implications for rate of deforestation where farmers depend on *tavy*. If one asks the rights questions, farmers are generally quite willing to relate how crop yields change over time and how many cycles can be practiced before *tavy* fields have to be abandoned.

On the other hand, one of the most positive aspects of *tavy* is that it is essentially a no-tillage cropping system. Rice is direct seeded in the ashes just after the cut and dried forest or fallow vegetation is burned. The root systems of the vegetation remain intact and the soil is not plowed or turned over. Even on very steep slopes, erosion is not all that high (although too high to be sustained over the long term). Turning the soil with the consequent destruction of root systems can result in disastrous levels of erosion if intensive soil erosion control measures are not used. This is especially a problem with ginger cultivation. Erosion can be successfully controlled with contour bands of appropriate species of perennial plants such as vetiver or well-managed *Tephrosia* strips.

Forest clearing for agriculture is also practiced in the Dry Forest of western Madagascar. This is similar to *tavy* in that the forest is felled, allowed to dry and then burned before a crop is planted. However, forest clearing for agriculture in the west is different from *tavy* in the east in that the fallow areas rarely regenerate back to woody cover. After soil fertility is depleted, the fallows generally convert to grass cover. The widespread occurrence of fire along with the exceptionally low ability of native Dry Forest species to recolonize such severely disturbed sites results in the “permanent” conversion of the site to *tanety* grasslands.

4.2. Socio-Cultural Aspects of Tavy

Tavy farmers often have very strong cultural ties to their slash-and-burn agricultural systems. *Tavy* is not just a cropping system, but also a way of life. The Malagasy reverence for “the way of the ancestors” certainly applies to the ethnic groups that practice *tavy*. The depth to which *tavy* is engrained in the cultural values of some ethnic groups is found in expressions such as, “A man who does not do *tavy* is not a Betsimisaraka.

Efforts to promote flooded rice cultivation in valley bottoms amongst the Betsimisaraka in the Beforona area have been confronted with the cultural belief that, “Only pigs wallow in the mud”. Such cultural beliefs and values are very powerful constraints that must be recognized and confronted. The Tanala in the Fianarantsoa area do not have the same cultural disdain for flooded rice cultivation. Most of their valley bottoms are intensively developed for rice paddies. Indeed, some say that they prefer bottomland rice and have only intensified their practice of *tavy* in relatively recent times as new areas suitable for flooded rice cultivation have become rare.

Tavy is also a constraint to the social structuring and cohesion of the communities to which *tavy* farmers belong. Villages in the *tavy* zone are frequently abandoned during the cropping season. *Tavy* farmers typically construct temporary dwellings in or near their fields and stay there with their families for months at a time. Families are scattered all over the village’s *terroir*. This greatly complicates such activities as agricultural extension, rural development programs and schooling for children. Just getting villagers together for a meeting during the cropping season can be problematic.

4.3. Historical Perspective

Lifting of controls *Tavy* was subject to strict controls during the colonial period. Permits were required and *tavy* was limited to the lower third of hill slopes. These controls continued to be enforced until national policies were changed in 1975. *Tavy* farmers up and down the eastern *tavy* zone refer to 1975 as the year when effective controls on *tavy* were discontinued. Although the laws remain largely unchanged, the word went out that officials would “look the other way”. The government adopted a de facto policy that “land and resources are for those who make use of them”.

Clearing of “primary” forest for *tavy* is technically illegal. The Chef CIREF in Ambatondrazaka told the author that *Eaux et Forêts* is not supposed to issue permits for the clearing of rainforest for *tavy*. The author repeatedly heard accounts of just the opposite occurring quite commonly, especially in the highly threatened Low Altitude Rainforest. In October the author witnessed several new *tavy* fields of freshly felled rainforest within full view of the Antananarivo to Tamatave *Route National 2*, the most heavily traveled highway in the country. Clearly, there are no effective controls on *tavy* at the present time.

Collapse of the cash crop economy East of the escarpment in the Fianarantsoa Region, the lifting of restrictions on *tavy* corresponded with the collapse of the cash crop economy. The socialist government nationalized large plantations of coffee and other cash crops that had been owned by colonial companies such as the Marseillaise. Expatriate managers and private plantation owners left. Many of the plantations were taken over by absentee land owners with frequently questionable title or claims to the land. The level of investment in, and management of, the plantations plummeted as did employment and yields. Many of the employees of the plantations turned to *tavy* farming as the only economic alternative that required very little investment other than a man’s physical labor.

Cash crops were never as important in the Moramanga Region. On the east side of the Ankeniheny Forest south of Andasibé, *tavy* rice and cassava are virtually the only crops cultivated today, even though the area is accessed by an all weather dirt road that would permit the marketing of cash crops with relative ease.

Sectoral confusion on mandates for dealing with tavy. The government has historically viewed *tavy* as a forestry issue and gave *Eaux et Forêts* the mandate to deal with *tavy*. *Eaux et Forêts* took a regulatory approach to *tavy* without addressing the basic problem of its unsustainable nature. Jean-Louis Rakotomanana of FOFIFA has stated that the government has never had an agricultural extension program in the *tavy* zone. This seems incongruous because *tavy* is an agricultural system on which a significant portion of the population of Madagascar depends.

Tavy and land tenure. As discussed earlier, traditional land tenure systems usually accord land tenure to the first family or clan to clear the natural forest and put it under

cultivation. This is an additional factor contributing to accelerated forest clearing for *tavy* above and beyond the immediate needs for land for cultivation. Lack of community controls on access to forest lands within their traditional *terroir* can lead to a land rush mentality where everyone seeks to clear a bit of the forest to establish traditional tenure rights.

History of Government and Donor Programs in the Tavy Zone Tens of millions of dollars of donor moneys have been invested in the *tavy* zone over the past three decades. These have included the programs *Aménagement des Vallées Forestières (AVF)*, *Aménagement Intégré des Vallées Forestières (AIVF)* and *Opération Savoka*. FAO has been a key player. Although the net result of all of these programs has been negligible, it would be wise for LDI to seek to learn from the wealth of project experience in dealing with the same challenges as those confronting LDI. A major accent of all these programs has been the development of flooded rice cultivation in valley bottoms in the *tavy* zone. Piecemeal information would indicate that very little remains of all the infrastructure investment in flooded rice cultivation from these programs. A lot of USAID counterpart funds have been invested in small dams and irrigation infrastructure in the *tavy* zone.

LDI is fortunate to have the FOFIFA Alternatives to Tavy Research Station at Beforona within its Moramanga Region. There have been 30 years of research on *tavy* alternatives at Beforona. The author visited the Station in 1989 and '90 when intensive research was under way to develop sustainable rainfed cropping systems with a strong focus on agroforestry and alley cropping for soil fertility maintenance. The Swiss have invested very heavily in research in the Beforona area. The most promising technologies for extension include ginger cultivation on lower slopes, hog production and perennial coffee and fruit tree culture on lower *tanomboly* slopes. Extendible cropping systems for rainfed rice and/or other food crops as alternatives to *tavy* have not been developed.

4.4. Strategy Options for Developing Alternatives to Tavy

One should have no illusions about the difficulty of finding effective alternatives to *tavy*. The colonial administration, the post-independence government and a host of donor-funded projects have sought unsuccessfully to end or reduce the practice of *tavy*.

Strategies for finding alternatives to *tavy* should include the following:

- Communications strategies for changing cultural values;
- Accent on the promotion of perennial cash crops;
- Improved access to credit, inputs, markets, information;
- GELOSE/CBNRM;
- Assist in resolution of tenure of former plantations.
- What role for enforcement?

4.4.1. Communications Strategy for Changes to Cultural Values

The author proposes that LDI develop a communications strategy with the objective of changing cultural values that keep *tavy* farmers wedded to their unsustainable land use

system. Such a strategy should be geared towards achieving the following:

- Convincing *tavy* farmers that there is no future in *tavy* for their children and grandchildren. This should include the message that current trends will result in the disappearance of the forest leaving their descendants with fewer options and resources than they have now and the absolute obligation to find other means of making a living;
- Convincing *tavy* farmers that there are other, more attractive alternatives to *tavy*;
- Convincing *tavy* zone residents of the value of investing in the education of their children.

The communications methods could include the following:

- Dialogue/negotiations with *tangalamena* and other community leaders;
- Field trips for community leaders to demonstrate the extent of the forest areas that has been lost within their lifetimes, how little forest is left, and how residents of highly degraded *tanety* areas have had to deal with the loss of forests, springs and usable *tavy* lands.
- Field trips for community leaders to visit productive, lucrative land use systems other than *tavy*.

4.4.2. Identification and Promotion of More Attractive Alternative Crops

It is doubtful that the cultivation of rainfed rice or other relatively low value grains could ever be made sustainable and profitable in the *tavy* zone. Soil fertility cannot be maintained using fire to prepare fields for planting. Past research conducted at Beforona was not successful in developing rainfed techniques for food crops that do not include the use of fire. This, of course, does not mean that sustainable rainfed techniques are impossible to develop, but it does indicate that it will not be easy.

LDI should concentrate on the identification and promotion of the economically most attractive mix of crops possible in each *tavy* zone where they will work. The thrust of the effort should be to develop cropping systems that are more lucrative than slash-and-burn rice or cassava. The *tavy* zone is ecologically poorly suited for the production of annual food crops. It is ecologically much better suited for perennial cash crops. The following criteria should be considered:

- Preferences should be given to perennial crops whenever possible. Sustaining soil fertility and site productivity for perennial crops is far less problematic than for annual crops. Perennial crops include coffee, bananas, other fruit trees, cinnamon and sugar cane. Many essential oil crops are perennials.
- People will generally protect high value perennials from fire. The soil fertility/productivity of the entire site that is protected from fire will benefit.

- LDI should seek to identify and to promote the most lucrative, highest value varieties of crops for each site where they work. Transport distance and cost or effort to the nearest road/market should be a key factor in matching crop to site. Similarly, the most cost-effective cultural techniques should be identified and promoted for each crop.
- Clear preference should be given to the promotion of cropping systems that compete with or conflict with labor/input demands for *tavy*. A classic example is vanilla. The timing of labor demands for the hand pollination of vanilla is such that a farmer must either grow vanilla or do *tavy* – he can't do both. The agricultural calendar and labor demands of each potential crop should be analyzed in comparison to that of *tavy* (the reader should consult work on this subject done by Paul Ferraro.)

4.4.3. Improved Access to Credit, Inputs, Markets and Information

Moving subsistence *tavy* farmers towards a market-oriented, cash crop economy will require access to number of classic services common to modern, business-oriented agriculture. The exact mix must be determined as a function of the specific site conditions and cropping systems. The existence of qualified partners for providing or facilitating such services must be factored in to what is doable. The appropriate phasing of the provision of these services should be studied carefully. Key measures include the following:

- **Rural Credit** is one of the most challenging types of services to provide, but a critical one. Very careful choice must be made in the selection of the partner(s) to provide credit. Lack of credit can severely limit the options available to farmers for intensifying their production.
- **Inputs** include such things as improved seed, nursery stock, soil amendments, pesticides, and agricultural implements. Improved agricultural systems/techniques reliant on such inputs are no good if the inputs are not available. Input supply should be almost totally a private sector function. This should be seen as an opportunity for enterprise development in the LDI SIZs.
- **Markets and Market-Related Information** One of the greatest impediments to cash-cropping in Madagascar is probably the marketing systems and farmer access to good information of the markets. The very recent experience with litchi exports from the Manakara area is a classic case, but not that unusual. Under prevailing marketing systems, farmers often get no bonus for high quality products. Collectors conspire to reduce competition. Farmers may lack means to verify the accuracy of scales/measures used by collectors. Farmers lacking the means of storing their product are forced to sell at harvest time at whatever price the collector will offer. Farmers lack information on market prices, collectors' schedules, and other key market information. Farmers lack the organization needed to pool their resources to hire transport to move their produce to regional

markets where they could realize a hire profit margin. Any measures to address these constraints should improve the profitability of farmer investments.

4.4.4. GELOSE/CBNRM

We have discussed previously how open access to forest resources combined with traditional tenure rules that award tenure to the first family/individual to clear the forest for *tavy* can create a land rush mentality amongst *tavy* farmers, especially where immigration is a factor. Please refer to the chapter on land and resource tenure for strategy options on how GELOSE/CBNRM could play a role in reducing the clearing of “primary” forest for *tavy*.

4.4.5. Tenure Problems of Former Cash-Crop Plantations

Tenure issues of the former cash-crop plantation are beyond LDI’s capacity to resolve, but LDI should contribute to the research of an equitable solution. LDI should strive to get AGERAS and regional and national authorities to address this problem. LDI could contribute to background and economic assessments of the situation as well as contribute to the organization of appropriate fora for debating and seeking solutions.

Few of the old plantations are located contiguous to, or very close to, remaining forest areas. However, the revitalization of these old plantations and the associated creation of new employment could diminish outmigration towards forested areas and could, perhaps, even draw people out of the *tavy* zone in search of employment in the plantations.

4.4.6. What Role for Enforcement?

It is almost certain that ecologically and technically viable economic alternatives to *tavy* can be found. But, as already argued, the cultural ties to *tavy* as a way of life are strong. Cultural values are often more problematic, requiring longer time periods to change than the development of technical solutions. Can the change in values be brought about rapidly enough in the absence of enforcement of laws prohibiting the clearing of new forest for *tavy*? The answer is not obvious; this should be kept and debated as an open question. Permitting open access to the rainforest for *tavy* slash-and-burn agriculture could be construed as making a joke out of the Environmental Action Program and of the Environmental Program 2. Simple enforcement without viable alternatives for the *tavy* farmers is almost certain to fail. LDI can help identify and extend the alternatives. Can this be enough in the absence of enforcement?

5. Institutional/Policy Constraints and Strategies

7.3. Present Situation

MEF During the course of the author’s field work, many Malagasy and expatriats at

many levels related stories of lack of capacity, lack of motivation and of outright corruption within the Ministry of *Eaux et Forêts*. Some of the key factors are the following:

- Field agents in charge of huge geographic areas have no means of transportation, no operational budget;
- Families of forest agents are frequently separated for lack of suitable schooling and other amenities in the areas where foresters are posted;
- Francophone forestry emphasizes enforcement and repression rather than resource management and extension. Foresters are often feared by local populations;
- Salaries are extremely low, but the value of the resource that agents are responsible for is very high. Enforcement authority adds power to the role of the forester. This is a classic formula that favors corruption;

Some of the types of problems related to the author include the following:

- Logging (*permis d'exploitation*) and *tavy* permits being issued or “sold” by forestry agents within *forêts classées* in the highly threatened Low Altitude Rainforest zone, this without any regard to the sustainable productive capacity of the forest;
- Illegal logging rampant in priority conservation corridors targeted as the focus of AGERAS regional planning efforts in both the Moramanga and Fianarantsoa Regions;
- Pilot community-based forestry management projects whose main problem is the arrival of *exploitants forestiers* armed with *permis d'exploitation forestière* delivered by forestry agents in cities remote from the region concerned without the knowledge or approval of the local forester in charge;
- Fines collected by forestry agents but not deposited in the Forestry Fund;
- Recently felled primary forest for new *tavy* fields within full view of the most heavily traveled highway in the country;

Role of the Justice System

It is doubtful that any country can advance very far without a free press and a functioning justice system. The written media in Madagascar now enjoy quite a high degree of freedom of the press. The justice system, however, has fundamental problems. In the environment sector, the author has heard stories for the past decade about offenders being taken before the courts for the violation of forestry laws and then being released with little or no sanctions applied.

7.4. Strategic Approaches

Problems within the MEF are fundamental and basic. They are well beyond the capacity of LDI to resolve. USAID has been a leader within the donor community in bringing

attention to bear on these problems and in researching solutions. The present situation makes a mockery out of the whole Environment Program 2. USAID and the other donors must apply the pressure needed to achieve fundamental reforms within the MEF.

If MEF would agree, MIRAY and/or AGERAS could develop public access databases of permits issued by MEF agents, of fines levied and deposited in the Forestry Fund and the like. Such a transparent database open to the public and to the press could contribute to pressures for reform.

8. Challenges and Opportunities of Invasive Woody Exotics

8.1. Present Situation

All of the *tanety* grasslands in Madagascar that used to support forest before the arrival of man on the island can be viewed as empty environmental niches. The ecological conditions are favorable for supporting tree and forest cover. Grasses presently cover them because the endemic Malagasy forest species are incapable of regenerating under the regime of man-caused disturbances that prevail. The most severe disturbance is fire, but others include livestock grazing, woodcutting and the extinction of seed-dispersing wildlife species.

Although endemic forest species are not capable of re-invading the *tanety*, there are numerous exotic (non-native) species that are very well adapted to colonize and thrive on these severely degraded sites. The colonization of Malagasy grasslands by invasive woody exotics is one of the most dramatic changes to Madagascar's landscape ecology that is taking place today. It is also one of the least noticed, least publicized, least studied and least understood ecological phenomenon taking place today.

Eastern invaders The spread of invasive woody exotics is by far the most dramatic at lower altitudes between the eastern escarpment and the Indian Ocean on lands formerly occupied by Low Altitude Rainforest. The "spontaneous" reforestation of the landscape along the *Route Nationale 2* to the southeast of Brickaville that has taken place since 1989 is the most dramatic "positive" transformation of a landscape that the author has ever seen. Roughly half or more of the *tanety* along more than 30 km of the highway have been colonized by *Grevillea banksii* in this nine-year period. *Grevillea* is established and spreading rapidly at many sites from Tolanaro to Vavatenina. *Grevillea banksii* is probably the most aggressive invader in the whole country. Its winged seed that spreads with the wind and its phenomenal ability to invade sparse *tanety* grasslands gives it an ability to disperse more rapidly than nearly all other invaders.

Two other active colonists in the area are an Australian relative of Eucalyptus with the common name resembling "niaouli" and Eucalyptus species.. Niaouli is a highly efficient colonizer of east coast wetlands, and also invades *tanety* uplands. Another aggressive, eastern, low altitude colonizer is a medium sized species of yellow bamboo. It has colonized large areas southeast of Mananjary and is also well established between

Brickaville and Beforona.

There may be few areas of low altitude grasslands left in the east within a few decades.

High Plateau Invaders Invaders on the High Plateau include the following:

- *Acacia dealbata* commonly called mimosa;
- *Pinus kesyii* and *P. patula*
- *Eucalyptus* spp.
- *Lantana camara*
- A species of guava
- *Melia azadirachta*

One of the factors impeding the spread of exotics on the high plateau is the heavy demand for fuelwood and other products due to the high population density combined with uncontrolled or open access harvest of fuelwood from these invasive exotics. *Acacia dealbata* is probably the most aggressive invader on the High Plateau, but it is now typically harvested in most areas when it is only two or three centimeters in diameter and before it can produce seed. The ecological conditions and the human land use pressures on the High Plateau make the conditions for the invasion and spread of exotics less conducive than east of the escarpment.

Mahajanga Region Invaders Mahajanga presents a more harsh climate than the east or the High Plateau, but some invaders have become established here also. The major one is a species of *Zizyphus* – the species name assigned varies in different reference documents. It is native to Africa and has the typical form of a semi-arid zone, thorn bush or small thorn tree. It has a small, edible fruit that is probably responsible for its introduction to Madagascar. It has probably been here for a long time. It is not clear how rapidly it is spreading.

Three relatively new invasive woody exotics that have only been introduced in the last 15 years or so are the three Australian acacias *Acacia mangium*, *A. leptocarpa* and *A. holocarpa* (sp?). All three have been introduced at the *Station Forestière d'Antsahantia* about 20 km NE of Mahajanga near the coast. The author visited these plantations with LDI regional staff. Parts of each of the areas planted to each of these three species have been subject to wildfire. All three species are regenerating, some of them very vigorously, after the passage of the fire.

The dangers of exotic invaders

One of the greatest dangers of invasive exotics is the risk that they may invade natural ecosystems and replace native species leading to severe habitat disturbance and possible extinctions. Relatively little of this seems to have happened to date with exotic plant species (Rats and wild pigs have been very successful animal invaders). *Lantana* has invaded portions of the Amber Mountain ecosystem. A species of wild guava resists replacement by the native forest species in Ranomafana, but it is not clear that the guava

is capable of invading the forest – it may be occupying very old *tavy* fallows. Niaouli may be much more successful in replacing native wetland species, although the author is not aware of any studies being done on this.

The danger will always exist that other exotics not yet introduced into natural ecosystems will be capable of invading and severely disturbing them. For example, *Prosopis juliflora* and *P. chilensis* are two of the more successful invaders in the world. They would probably be very successful colonizers in western Madagascar and might be capable of invading the Dry Forest itself.

8.2. Strategy Options Involving Invasive Woody Exotics

Invasive woody exotics present a major opportunity because of their ease and low costs of establishment. Once established, they can regenerate and spread all on their own. They present a danger because if one decides at some point after their introduction that one made a mistake and that one wants to eliminate the species, it may be very difficult and expensive or impossible to do so. Also, as previously mentioned, there is the danger that certain exotics could invade natural ecosystems.

Two reasons for introducing invasive are identified:

- The invasive exotic species in question has desirable qualities that clearly outweigh any disadvantages;
- An area is actively being invaded by an undesirable species and one wants to establish a more desirable species to prevent or diminish the establishment of the undesirable species.

Many invasive species may be capable of invading *tanety* grasslands while being incapable or having a feeble capacity of invading established stands of other exotic species. Most invasive exotics are pioneer, sun-loving species. They are adapted to colonizing open, sun-lit areas. Pioneer species are usually incapable of regenerating under the dense shade of closed canopy, established forest stands. This is why most (but not all) invasive woody exotics that can colonize grasslands cannot invade natural forests.

Examples of advantages of exotics Invasive woody exotics are capable of producing most of the same benefits as other woody species. They can potentially yield fuelwood, charcoal, construction wood, and non-timber forest products such as nectar for honey production, can improve soil fertility and can serve to enhance watershed and hydrological functions. Two examples from Madagascar are as follows:

- *Grevillea banksii* produces an excellent firewood and a good charcoal. There is also evidence that it is good for soil fertility. The author has witnessed excellent improvement to soil structure under a *Grevillea banksii* stand and has had one farmer southwest of Brickaville tell him that it is excellent for improving soil fertility. The WWF/Andohahela project conducted a test of cropping after harvest of a *Grevillea banksii* stand NW of Tolagnaro following a suggestion by the author several years ago. Cassava was

successfully raised on soils that are normally not used for agriculture. Two or three different treatments were compared, but not what may have been the most interesting comparison of the yields on a harvested *Grevillea* stand with that on a former *tanety* that had not been planted to trees was not done.

- *Acacia dealbata* is used for fuelwood and for tannins from its bark. Near Andringitra, farmers recognize its soil fertility enhancement capability and do a sort of mimosa *tavy* for potato cropping in stands of this species.
- The three Australian acacias introduced at the *Station Forestière d'Antsahantia* can all be used for fuelwood and charcoal.

Opinions of the scientific community on invasive woody exotics The author discussed the subject of invasive woody exotics with several of the main taxonomists/biodiversity researchers in Madagascar. Each was asked what they thought of the idea of introducing pioneer species of exotics in *tanety* for the purposes of urban fuelwood/charcoal supplies, for soil fertility enhancement or for other similar benefits. The author was quite surprised at the general agreement of these researchers. Most consider that the potential advantages are substantial and that the risks, especially of the well-known pioneer species of exotics such as *Grevillea banksii* and *Acacia dealbata*, of invasion of natural forests are minimal.

Strategic opportunities for LDI to use invasive woody exotics

Exotics for urban wood-based fuel supplies A major pressure on the Dry Forests within 130 km of Mahajanga is woodcutting for charcoal production for the urban market of Mahajanga. Nearly all the charcoal for Mahajanga comes from the Dry Forest. The harvest is largely uncontrolled and unsustainable.

Within 100 km of Mahajanga, there are huge areas of *tanety* that have very marginal value for agriculture or range in their present condition, but that have the potential for growing trees and for producing fuelwood, charcoal and other wood products. The Australian acacias growing at Antsahantia appear to be adapted to at least part of this areas. *Grevillea banksii* were successfully direct seeded in this zone by the CAP Project a year ago and appear healthy. All four species have the potential of being direct seeded on these *tanety* for fuelwood and charcoal supplies for Mahajanga.

This would be an excellent type of commercial enterprise to be undertaken by villagers as community-based NRM through GELOSE. Direct seeded techniques need to be tested and improved upon. Fire management would be essential, especially until trees reach fruiting age. Early dry season burns to prepare firebreaks should provide protection.

Similar opportunities for producing wood-based fuels exists for the Fianarantsoa, Tamatave and other urban markets in the LDI regions. However, these would be primarily as an enterprise opportunity for communities or individuals. The rainforests in these two regions are not exploited very extensively for urban fuel markets.

Exotics for soil fertility enhancement The ability of invasive exotics to improve soil fertility should be investigated much more closely. This could include both farmer surveys and soil lab analysis. Individuals or communities could plant species that are found to be effective on unproductive tanety. LDI could help in the testing and development of direct seeding techniques and associated fire management. Options could include direct seeding of relatively small plots at high densities to establish closed stands or direct seeding of large areas with widely spaced clumps of trees. This would grow, produce seed and then colonize the empty areas between the clumps. Clumps rather than lone trees would allow for pollination and seed production.

Where markets exist for wood fuels or other products, these could be secondary benefits of exotics planted for soil fertility enhancement.

7.0. Demography and poverty

7.1. Present Situation

Demographics, agriculture, economic development and the environment are all intimately linked. The success or failure of efforts to conserve priority ecosystems is dependent on future development in these other sectors. Some of the key aspects of the present situation are the following:

- The population of Madagascar will double in the next 25 years, even if growth rates begin to drop dramatically in the near future;
- Agricultural production will have to double in the same time period, just to maintain the present, unacceptably low, level of human nutrition;
- If increases in agricultural production are achieved through the ongoing process of agricultural extensification, then nearly all of Madagascar's remaining natural ecosystems will be destroyed and the socio-economic conditions of the Malagasy people will become even more desperate than at present. Furthermore, the rate of destruction will accelerate.
- Malagasy have become desperately poor. Half of the population have a caloric intake less than the minimum considered necessary for a normal, active life;
- With increasing poverty and desperation has come increasing mobility. Severe poverty leads people, especially young men, to travel wherever means of livelihood exist, however, meager, legal or illegal.

Key Challenges

LDI will intervene in selected zones within the three regions. However, over the mid to long term, LDI cannot be successful in isolation from the macro socio-economic conditions of the larger regional and national context. Reversing the present socio-economic trends will require the following:

- The development of conditions leading to rapid agricultural intensification;

- The creation of conditions conducive to rapid economic development.;
- The development of conditions that will lead to rapid, major decreases in demographic growth.

7.2. Strategic Conditions

Conditions Conducive to Agricultural Intensification

- Rapidly growing national markets resulting from economic development and urbanization;
- Good roads and transportation infrastructure;
- Ready access to affordable credit;
- Availability of agricultural inputs;
- Secure land tenure;
- Information on markets/prices/trends readily available to farmers and those involved in agricultural processing and marketing;
- Functional agricultural research and extension;
- Appropriate changes to cultural values.

Conditions Conducive for the Investments needed for Economic Development:

- Appropriate legal foundation;
- Functional justice system (invariably associated with a free press);
- Public infrastructure (transportation, telecommunications, etc.)
- Educated work force;
- Large scale investment. It is doubtful that this can be achieved without large-scale investments from outside of Madagascar. This will require the creation of a favorable investment climate for foreign investment.

Conditions Conducive to Major Decreases in Demographic Growth

Demographers and family planning specialists generally the following conditions as key factors that lead to rapidly dropping demographic growth rates:

- Generally high level of education for the general population, especially for women;
- Relatively independent status of women;
- Affordable access to primary health care;
- Relatively comfortable standing of living;
- Perceived scarcity of key resources (such as fertile farm land);
- Ready access to family planning techniques.